NOAA's National Geodetic Survey: Report to the TRB Committee Summer Workshop

July 2003

TRB Committee Summer Workshop

July 28-August 1, 2003

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National Geodetic Survey

NGS Status Report

Continuously Operating Reference Stations (CORS)

CORS Development and Usage

• NGS added 22 stations to the National and Cooperative CORS networks during the third quarter of FY 2003. These networks collectively contain a total of 433 stations; 387 stations participate in the National CORS network.

• NGS and NOAA's Center for Operational Oceanographic Products and Services (CO-OPS) have completed installing six CORS at selected U.S. water-level sites on the Great Lakes. This network complements five CORS established at Canadian water-level sites on the Great Lakes by Natural Resources Canada and the Ohio State University (OSU). OSU and CO-OPS plan to establish several more CORS at selected Great Lakes water-level sites.

• The National Science Foundation awarded $30 million to the University Navstar Consortium, Inc. (UNAVCO) and others in FY 2003 to launch the 10-year EarthScope Program. A major portion of this program will be the establishment of the Plate Boundary Observatory (PBO), which calls for the installation of about 875 new permanent GPS base stations in the western United States, including Alaska, to monitor crustal motion. UNAVCO will manage the PBO.

• The CORS Team estimated 3D positional coordinates and velocities for 461 globally distributed GPS sites, including all National CORS. The solution included data spanning the 1994 - 2001 time period. The CORS Team presented results in June 2003 at the Joint UNAVCO-IRIS Workshop in Yosemite, CA.

• NGS has updated CORSAGE-2 so that the web-based utility uses CORS metadata from existing "shape files" instead of from the NGS Integrated data base (NGSIDB). The shape files are updated once per day from the NGSIDB. As a result, the new version of CORSAGE-2 will upload onto a user's computer about twice as fast as the old version.

• The U.S. Coast Guard convened a meeting in Portsmouth, VA, in June to discuss plans to improve the Nationwide Differential GPS (NDGPS) network. Their goal is to enable real-time positioning with an accuracy of 30 cm. They proposed initiatives to (1) establish more stable sites, (2) deploy antennas that are more multipath resistant than the current NDGPS antennas, (3) broadcast a signal containing additional information, (4) incorporate better orbits and weather information into their positioning algorithm, and (5) develop algorithms that compute positions by using information from multiple NDGPS sites.

• NGS and NOAA's National Geophysical Data Center (NGDC) are collaborating to establish a "Parallel CORS Data Site" at the NGDC facility in Boulder, CO. During the second quarter of FY 2003, NGDC started collecting CORS data for stations in the maritime and Nationwide DGPS networks operated by the U.S. Coast Guard and the Wide Area Augmentation System (WAAS), operated by the Federal Aviation Administration. NGDC currently stores these data locally for 30 days. Also, NGS has established a dedicated T1 line between its campus in Silver Spring, MD, and the NGDC campus in Boulder, CO, to facilitate the exchange of CORS data between these two data sites. NGS personnel are now configuring the equipment needed to store more than 2 terrabytes of CORS data online at Boulder.

• The U.S. Coast Guard has converted all sites in the maritime and Nationwide DGPS networks from the X.25 communication protocol to the new Frame Relay protocol. NGS has been collecting data from these DGPS networks via the X.25 protocol since January 1996. The previous data collection system provided more than seven years of relatively robust and uninterrupted data collection.

The DGPS networks have always represented a critical part of the National CORS program and are continuing to grow. A review of the March log for User Friendly CORS shows that the DGPS sites make up 25% of all data requests to which this utility responded--demonstrating the benefit that our partnership with the Coast Guard and the U.S. Department of Transportation provides to the public.

• STATISTICS

The CORS ftp server distributed an average of 15,878 files per day during the third quarter of FY 2003, as compared to an average of 8,535 files per day during the second quarter of FY 2003.

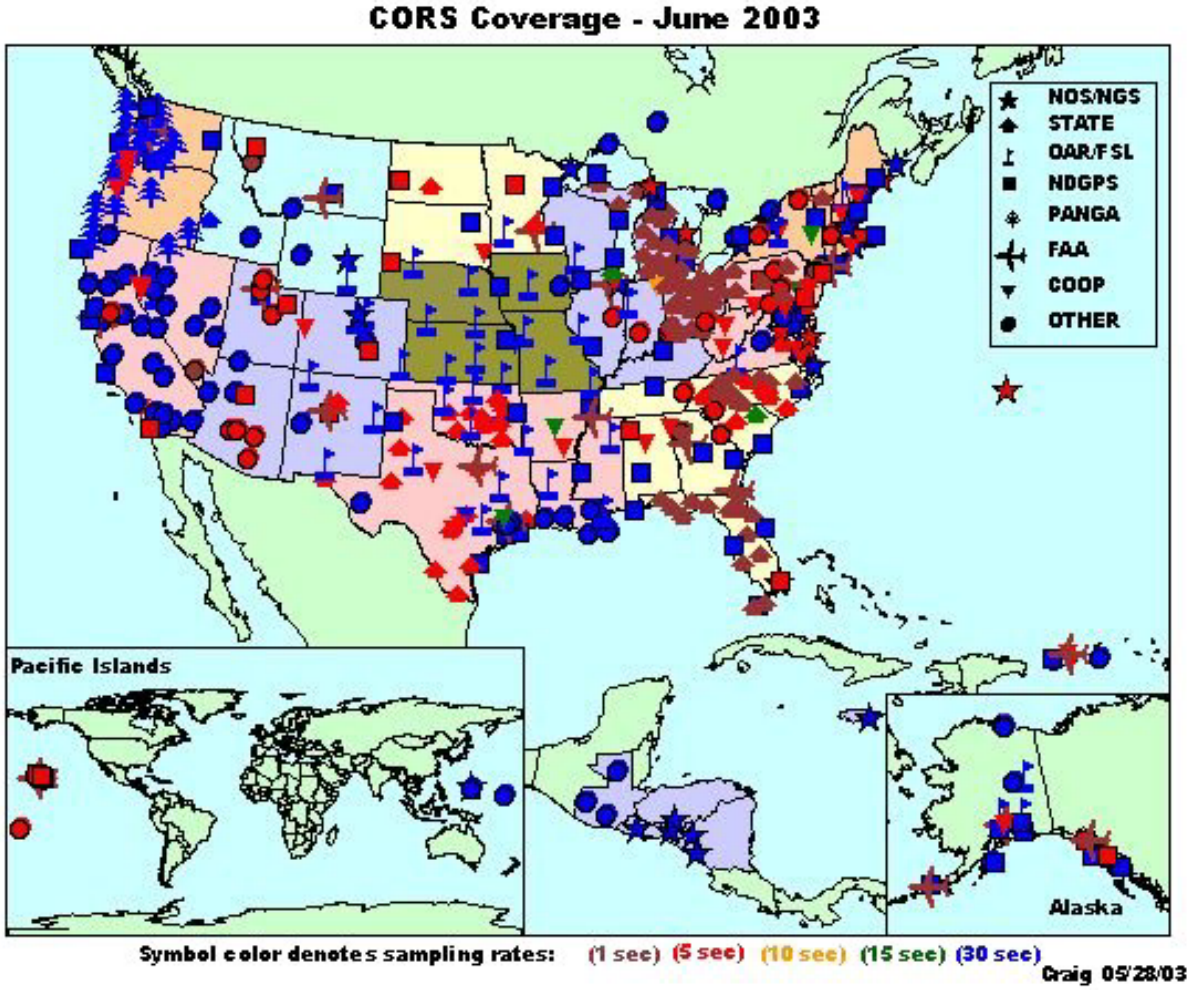
The User-Friendly CORS (UFCORS) utility distributed an average of 1,580 data sets per day during the third quarter of FY 2003, as compared to an average of 1,164 data sets during the second quarter of FY 2003.

The CORS Team responded to 617 email requests during the second quarter.

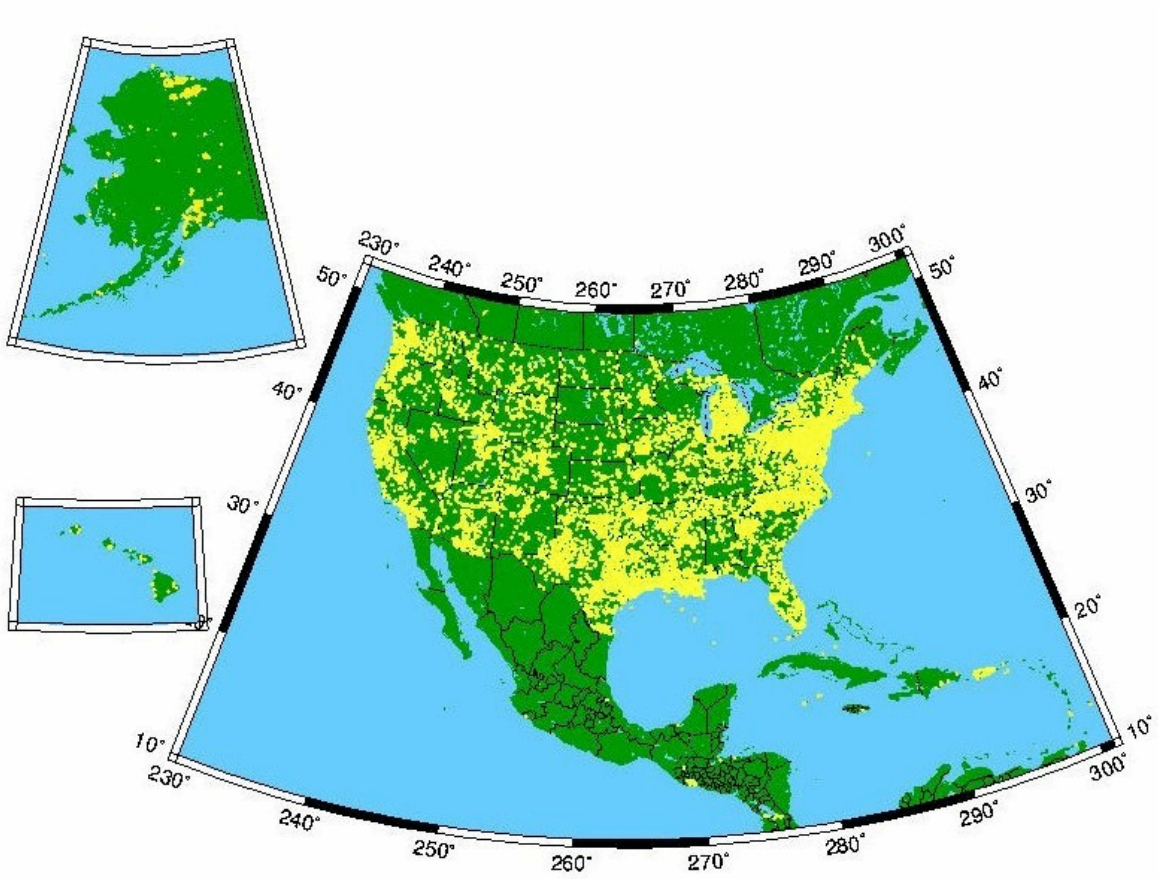
OPUS Growth

• OPUS users may now select Cooperative as well as National CORS to process RINEX data. This upgrade will provide users access to more and possibly closer base stations. OPUS processes RINEX data with respect to three CORS to provide users easy access to the National Spatial Reference System. OPUS supplies ITRF and NAD 83 (CORS96) coordinates as well as UTM & State Plane Coordinates in just minutes via the World Wide Web.

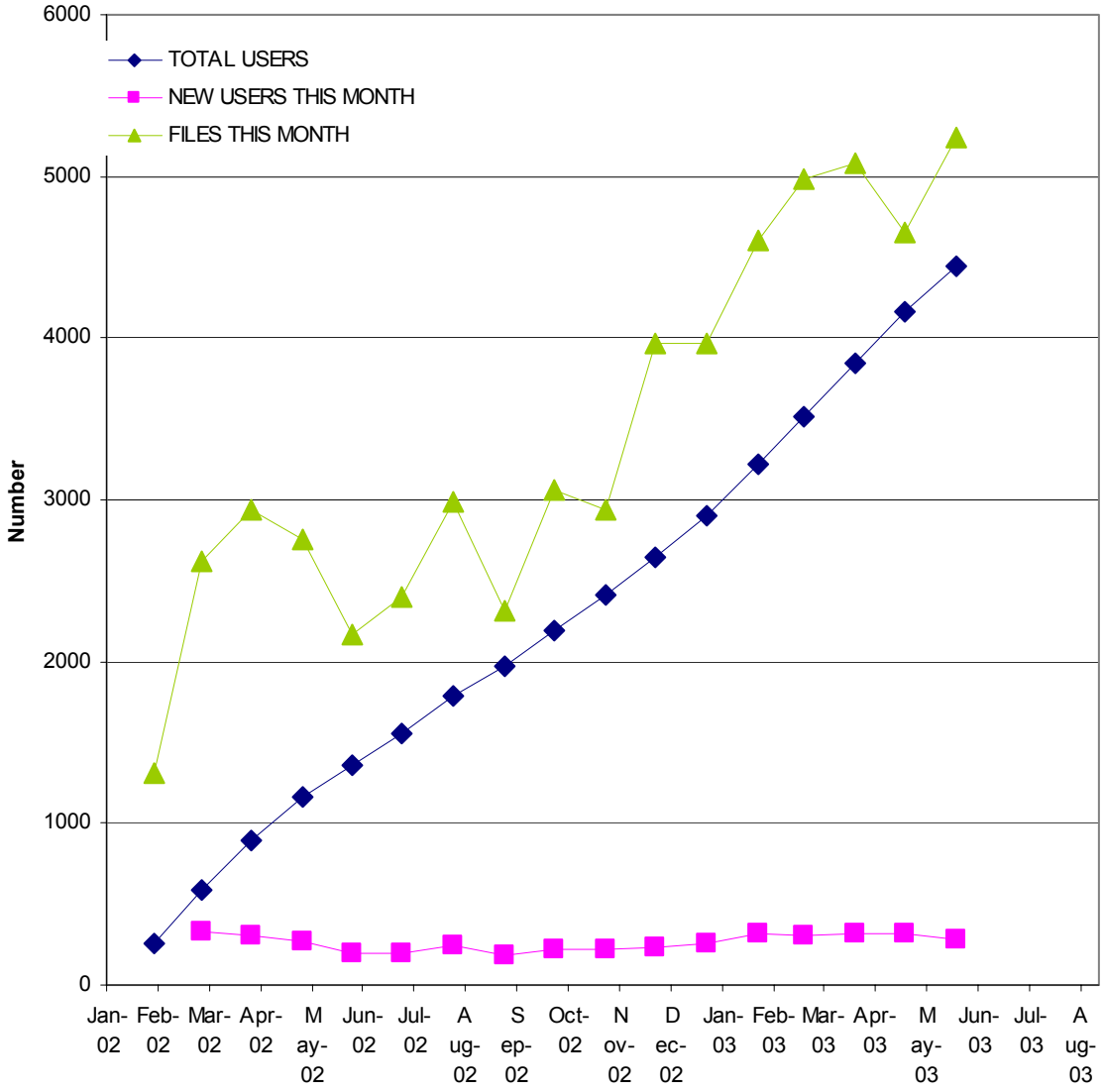
• OPUS processed an average of 164 data sets per day during the third quarter of FY 2003, as compared to an average of 86 data sets per day during the third quarter of FY 2002.


CORS Coverage - June 2003
NOS/NGS
STATE
OAR/FSL
NDGPS
PANGA
FAA
COOP
OTHER
Pacific Islands
Alaska
Symbol color denotes sampling rates: (1 sec) (5 sec) (10 sec) (15 sec) (30 sec)
Craig 05/28/03

Hits On OPUS Website Through June, 2003



OPUS USAGE

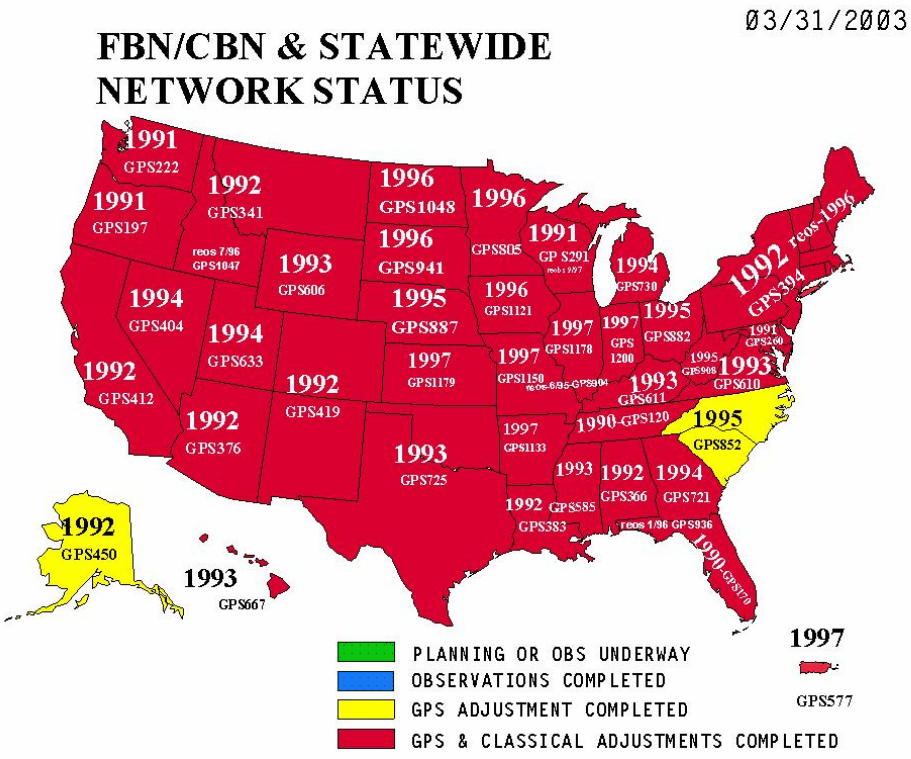

TOTAL USERS
NEW USERS THIS MONTH
FILES THIS MONTH
Number
6000
5000
4000
3000
2000
1000
0
Jan-02
Feb-02
Mar-02
Apr-02
May-02
Jun-02
Jul-02
Aug-02
Sep-02
Oct-02
Nov-02
Dec-02
Jan-03
Feb-03
Mar-03
Apr-03
May-03
Jun-03
Jul-03
Aug-03

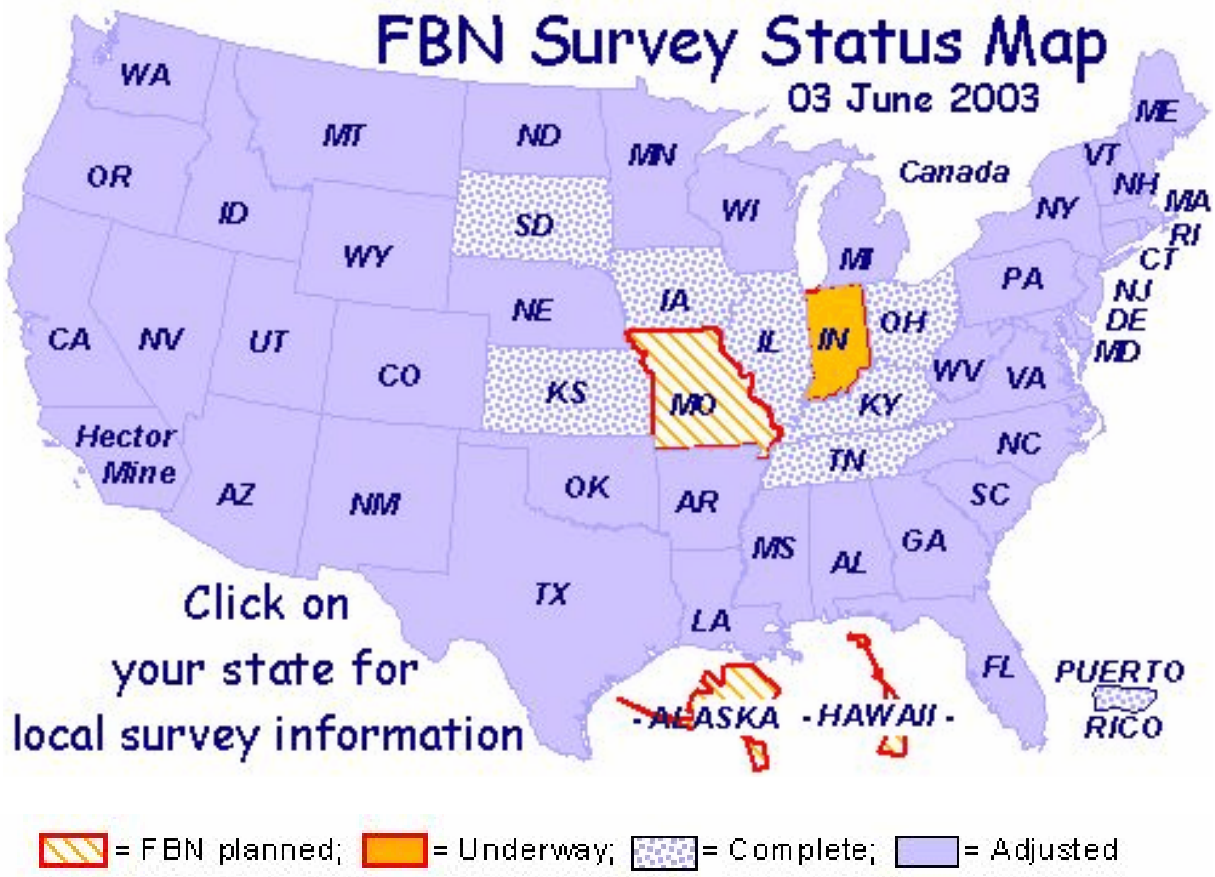
FBN and CBN Observations and Adjustments

Federal Base Network Surveys

Since July, 2002, NGS has, in cooperation with state and local surveying organizations, conducted survey observations to complete the height component of the Federal Base Network (FBN) in Illinois, Indiana, Iowa, Kansas, Kentucky, North Dakota, Ohio, and Tennessee. The FBN provides the critical foundation for an accurate, consistent National Spatial Reference System by furnishing a network of permanently marked points referencing highly accurate positions in four dimensions. Plans for the remainder of the year are to continue cooperative efforts in Missouri. The remaining states, Alaska and Hawaii, will be completed in 2004.

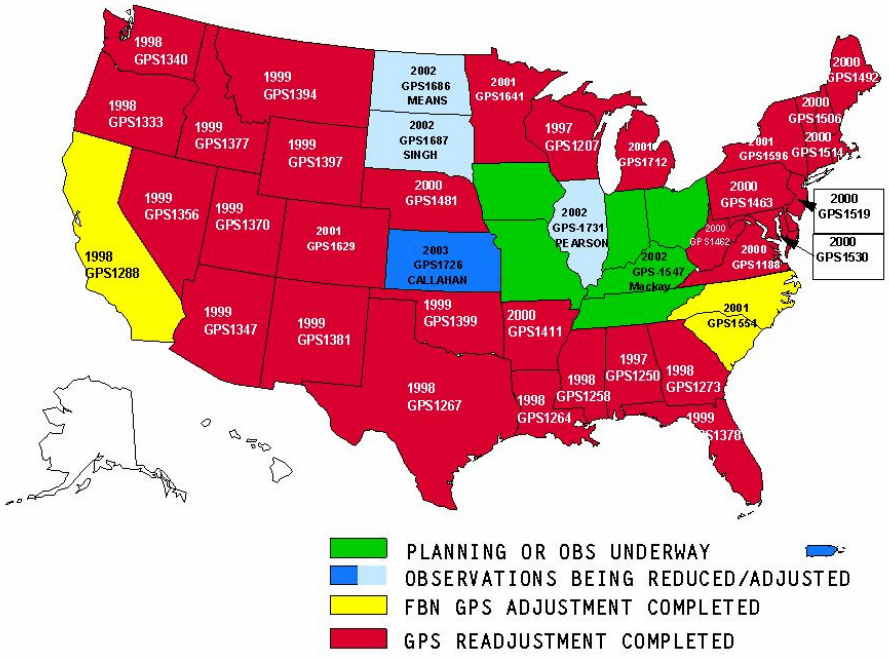
Please see the pages 9-11 for maps of FBN progress. Please see http://www.ngs.noaa.gov/PROJECTS/FBN/ or contact Steve.Frakes@noaa.gov for more information.


03/31/2003
FBN/CBN & STATEWIDE
NETWORK STATUS
1991
GPS222
1991
GPS197
1992
GPS341
reos 7/96
GPS1047
1993
GPS606
1994
GPS404
1994
GPS633
1992
GPS412
1992
GPS419
1992
GPS376
1996
GPS1048
1996
GPS941
1995
GPS887
1997
GPS1179
1993
GPS725
1996
1996
GPS1121
GPS805
1991
GP S291
1997
GPS1178
1997
GPS1150
1997
GPS1133
1994
GPS730
1997
GPS
1200
1995
GPS882
1995
GPS905
1991
GPS260
1992
GPS394
reos-1996
1993
GPS610
1993
GPS611
1990-GPS120
1995
GPS852
1993
GPS366
1992
GPS585
GPS383
1994
GPS721
reos 1/96 GPS936
1990-GPS170
1992
GPS450
1993
GPS667
1997
GPS577
PLANNING OR OBS UNDERWAY
OBSERVATIONS COMPLETED
GPS ADJUSTMENT COMPLETED
GPS & CLASSICAL ADJUSTMENTS COMPLETED


FBN Survey Status Map
03 June 2003
WA
OR
CA
ID
NV
MT
WY
UT
AZ
CO
NM
ND
SD
NE
KS
OK
TX
MN
IA
MO
AR
LA
WI
IL
MS
MI
IN
KY
TN
AL
OH
WV
GA
FL
SC
NC
VA
PA
NY
Canada
ME
VT
NH
MA
RI
CT
NJ
DE
MD
PUERTO RICO
Hector Mine
Click on your state for local survey information
- ALASKA -
- HAWAII -
= FBN planned; = Underway; = Complete; = Adjusted

12/31/2002

FBN/CBN Vertical Component



State Advisor Program

Additions to the Program:

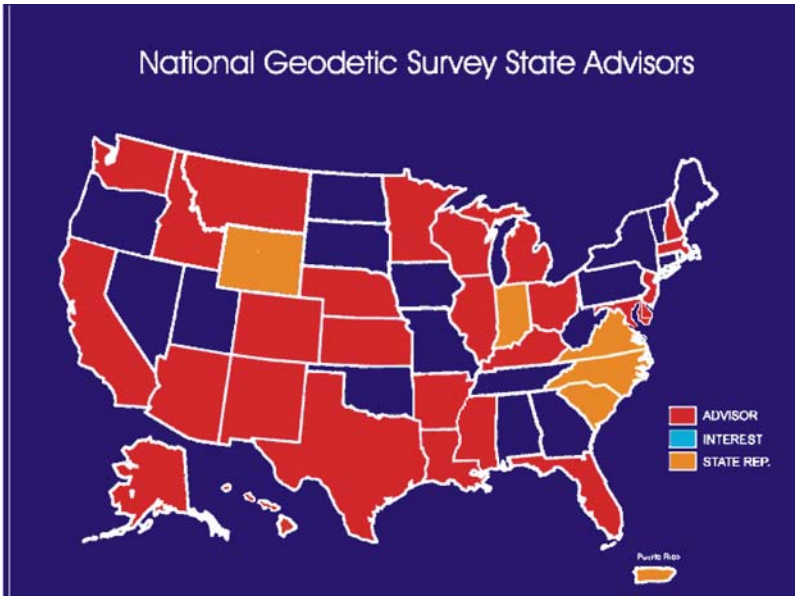
• The Washington state advisor is currently detailed in Arkansas to assist in the state program needs.
• A new adviser has been assigned to the state of Hawaii.
• The state of Vermont has a new advisor agreement in place and the state advisor position should be filled in the near future.
• A NOAA Corps Officer has been assigned as an advisor to the state of Alaska.
• The Texas advisor for the Harris-Galveston Coastal Subsidence District (representing a consortium of Texas political subdivisions.) has been selected and is currently in place under the agreement.
• A Second Texas advisor for the Corpus Christi agreement will be advertised in the near future.
• A new advisor has been selected and assigned to the state of Michigan to fill the position left vacant by the retirement of the previous state advisor.

Interest in the Program:

• An agreement with the Commonwealth of Puerto Rico is currently still in the negotiations stage.
• New York and Pennsylvania have expressed interest in the program.

Items of Note:
• There is currently a part time advisor in Delaware, whose duties are filled by an NGS person assigned to the Silver Spring Office.

Please contact Gilbert.Mitchell@noaa.gov or Ron.Travis@noaa.gov, or see the State Advisor Web site for more information:
http://www.ngs.noaa.gov/ADVISORS/AdvisorsIndex.shtml



Aeronautical Survey Program

Aeronautical Survey Program (ASP) Providing Valuable Data to Prevent Runway Accidents

NGS, in partnership with the FAA, is actively participating in the Safe Flight 21 program, which is a joint government/industry initiative designed to demonstrate and validate, in a real-world environment, the capabilities of advanced surveillance systems and air traffic procedures that will prevent runway incursions. NGS is producing prototype datasets for more than 50 U.S. airports, which include the precise locations of runways, taxiways, and parking areas. This information will be used in the creation of an airport GIS for the cockpit, assisting pilots and air traffic controllers in safely navigating their aircrafts at all stages of travel.

The FAA placed an order for 30 complete Airport GIS data sets for use by the aviation industry to develop the avionics needed to support this new data. The task involved development of specifications, generation of prototype data sets, and refinement of field party and quality control procedures before proceeding to production mode.

The ASP delivered 33 SafeFlight–21 GIS data sets to the SF-21 Program Office prior to September 30, 2002. This significant accomplishment was achieved through dedication and teamwork and was completed in addition to the normal Obstruction Chart requirements. The FAA has already asked for these data sets for 20 additional airports and will likely increase the order in FY-04.

An example of a Safe-Flight 21 product is shown on page 15.

Data to Support Procedure Development

NGS, in accordance with a series of interagency agreements with the FAA, continues to provide airport geodetic control, runway, navigational aid, obstruction, and other aeronautical data that is critical to the operation of the National Airspace System. Most of this data is source information obtained using field survey and photogrammetric methods. This data is used to develop runway approach procedures and obstruction charts. This site can be accessed at http://www.ngs.noaa.gov/AERO/aero.html.

Also, see http://www.ngs.noaa.gov/cgi-bin/airports.prl?TYPE=PACSAC for information about PACS and SACS established at airports across the country.

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LIDAR Research and Development

NGS, in partnership with the FAA, Optech Inc. and BAE Systems, is conducting research into the use of LIDAR to support FAA Instrument Approach Procedure development. The next test will occur in September 2003 at the Stafford, VA and Frederick, MD airports.

NOAA's Twin Otter aircraft will be used for the test. The next test will evaluate the feasibility of using two Optech 50 kHz Airborne Laser Terrain Mapper (ALTM), obstruction accuracy requirements and other standards and for the development of an Instrument Approach Procedure with the collected and processed data. NGS will perform a horizontal and vertical accuracy assessment of the ALTM data using ground control points collected by NGS. This assessment will evaluate the use of LIDAR to support the Aeronautical Survey process and determine whether the ALTM will detect the top of a structure, even if it is a thin object. Also, the research will make a determination of the cost and time for collecting and processing the LIDAR data to support instrument approach procedure development. Also, a digital camera will be integrated with the LIDAR system to provide a means of checking and classifying features extracted from the LIDAR data.

The DeHavilland Twin Otter (DHC-6)

Sensor Hole on the Twin Otter

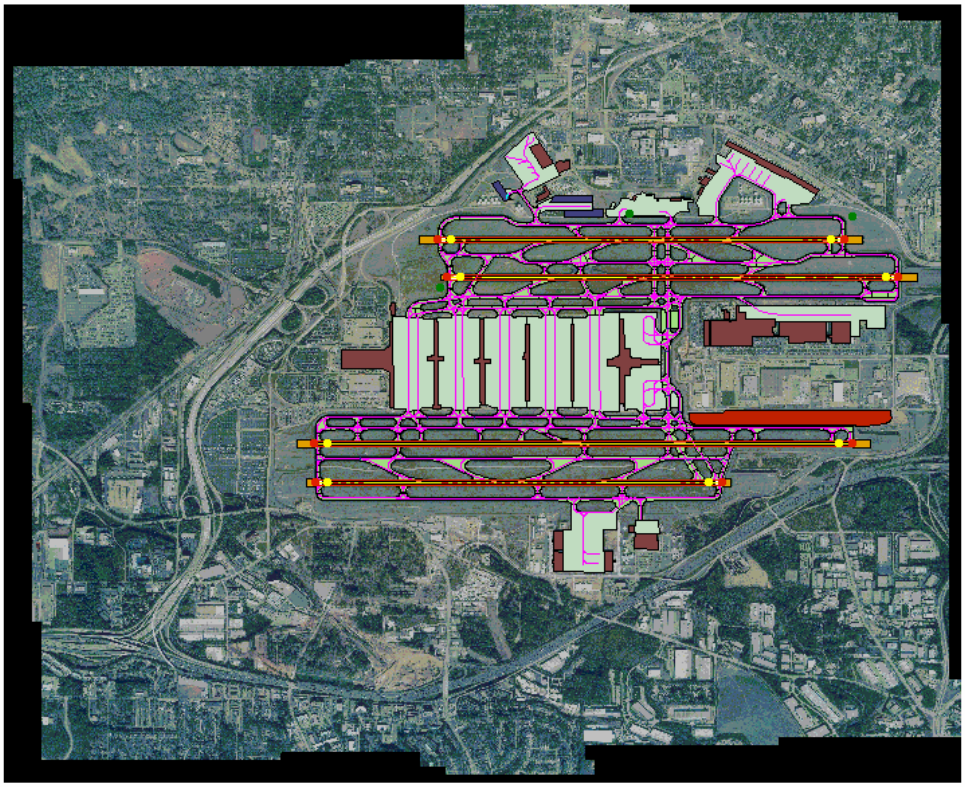
NGS Provides Document to the FAA to Outline a Process to Ensure Data Integrity from Private Survey Firms

NGS has provided a document to the FAA that outlines the process NGS will follow to ensure data integrity and quality is maintained by private survey firms who are supplying survey data to the FAA.

The ASP Web site http://www.ngs.noaa.ogv/AERO/aero.html contains more information about geodetic control for airports. Please contact Jeff.Hagan@noaa.gov for more information.

Sample of SafeFlight 21 Product

The William B. Hartsfield Atlanta Intl



Coastal Mapping

Status of Shoreline Mapping Contracts

Currently NGS has five NOAA contractors and two USACE contractors working on shoreline mapping projects. The locations of the projects are: southeast Alaska, south-central Alaska, three ports along the Columbia River, two areas along the Georgia coastline, southern Louisiana, and the port of Norfolk. NGS is currently preparing a second round of Task Orders for shoreline mapping. Please contact George.Leigh@noaa.gov for more information.

Comparisons of Mean High Water Shorelines Using Airborne LIDAR and Vertical Datum Transformations

The national shoreline provides the critical baseline for demarcating America's marine territorial limits, including its Exclusive Economic Zone, and for the geographic reference needed to manage coastal resources. The method used today by NOAA to delineate the shoreline is stereo photogrammetry using tide-coordinated aerial photography. However, LIDAR and other remote sensing technologies show promise for shoreline mapping.

Vertical datum transformations of high levels of accuracy can be obtained by combining known 3-D frame relationships, the GEOID99 geoid height model, a fit of the North American Vertical Datum of 1988 (NAVD 88) vertical datum bias, and gridded relationships between the tidal datums established from numerical ocean circulation models. This work was conducted for the Central California region and incorporated into VDatum, a user-friendly transformation tool.

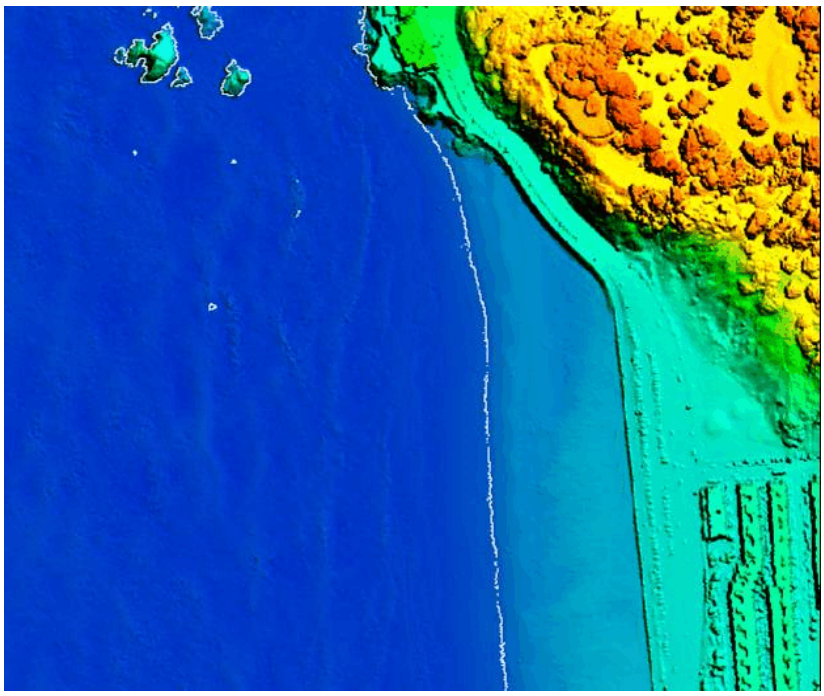
The Central California LIDAR data did not require explicit tide coordination. The LIDAR data were vertically referenced to NAVD 88 and were converted to the Mean High Water (MHW) tidal datum using VDatum. Once the LIDAR data were referenced to MHW, it was simple to automatically extract a zero contour line for MHW shoreline. This LIDAR-derived shoreline shows excellent agreement with the existing MHW shoreline from a NOAA nautical chart.

A methodology was also created for establishing a GRS80 ellipsoid/tidal datum relationship in areas where VDatum does not exist using static GPS techniques on tidal benchmarks. This methodology will also be compared to the VDatum LIDAR shoreline.

Please see the Coastal Mapping site for more information: http://www.ngs.noaa.gov/RSD/coastal/index.html or contact Jason.Woolard@noaa.gov.

Central California LIDAR Research Project

San Francisco outer coast



Shaded relief LIDAR image of San Francisco outer coast

Height Modernization

Status of Height Modernization Program

Over the past five years, $9.75 M has been appropriated for the Height Modernization Program. To date, approximately ninety percent of the funds have gone to the five states Congressionally-designated to receive funding through the NOAA Geodesy program. Height Modernization activities are ongoing in the states of California, Louisiana, Mississippi, North Carolina, and Wisconsin. NOAA's goal is to continue expanding the Height Modernization Program through regional partnerships.

Status of Height Modernization Projects in the States

NGS was given funds in FY 03 for Height Modernization efforts in Louisiana, Mississippi, and Wisconsin. This is in addition to the funds that have and continue to be provided to the California Spatial Reference Center and to North Carolina.

California - The California Spatial Reference Center (CSRC), accessible at http://csrc.ucsd.edu/, provides GPS data for more than 300 CORS in California. The CSRC's *A Master Plan for a Modern California Geodetic Control Network* was approved by NGS on March 12, 2003. Comments and perspectives on the draft plan received from participants of the 2002 Users Forum held in Riverside, California, helped to maintain a strong "user" focus in the development of the Master Plan. The Master Plan details the initial implementation of the Height Modernization Program in California, outlining the spacing of CORS and passive stations (in-ground monuments), as well as station accuracies, implementation costs, support and maintenance, and user information. Height Modernization surveys were completed in Contra Costa County, Yolo County, and Tuolumne County. Please contact Dave.Zilkoski@noaa.gov or Juliana.Blackwell@noaa.gov for more information.

Louisiana - After an initial $800,000 grant to Louisiana State University to establish the Louisiana Spatial Reference Center (LSRC), the LSRC received $400,000 for Height Modernization in 2003. The LSRC serves as a partner with NOAA in serving the state's geospatial needs. A Town Hall Meeting was held in New Orleans in November 2002. One of the first priorities in Louisiana is to develop a network of 25 CORS to provide statewide coverage. Currently eight CORS are operational. Another priority is the development of a Vertical Time-Dependent Positioning model to address the dynamic vertical control issues caused by subsidence. Analyses of historic geodetic data are underway to determine rates of subsidence and identify "reliable" survey marks for control purposes. In October 2002 and

in June 2003, NGS, LSRC, and others performed GPS and leveling surveys along two major evacuation routes in coastal Louisiana. The projects will determine up-to-date elevations of the roadways for safety planners and coastal managers. As the first state in the Gulf of Mexico region to implement the Height Modernization Program, Louisiana will be able to provide technical assistance and leadership to neighboring Gulf states. NOS representatives also presented seminars and overviews to the surveying community, state and Federal agencies, and local governments. Please contact Dave.Zilkoski@noaa.gov or Juliana.Blackwell@noaa.gov for more information.

Mississippi - The University of Southern Mississippi will be receiving a $400,000 grant to begin Height Modernization efforts in Mississippi. Technology transfer and cooperative efforts among neighboring states with similar issues such as Mississippi and Louisiana will expedite the development of the Height Modernization Program in the Gulf of Mexico region. Please contact Gilbert.Mitchell@noaa.gov for more information.

North Carolina - Height modernization surveys are underway in Gaston County, Henderson County, and Watauga County through private contractors. These three contracts will be standard Height Modernization surveys following the specifications in NOS NGS-58, "Guidelines For Establishing GPS-Derived Ellipsoid Heights," and the draft NGS "Guidelines for Establishing GPS-Derived Orthometric Heights." In Wake County a research project through a fourth contractor is underway to evaluate the specifications and procedures of NOS NGS-58. A fifth survey in Mecklenberg County will begin in late 2003. Outreach, education, technology transfer, and software support for Height Modernization activities are being conducted by NGS and the North Carolina Geodetic Survey through a cooperative agreement with North Carolina Agricultural and Technical State University. This year, three Users Forums were conducted in Asheville, Greensboro, and New Bern to inform users about the Height Modernization Program and gather feedback about the proposed Height Modernization activities within the State. Please contact George.Leigh@noaa.gov for more information.

Wisconsin - In 2003, the Wisconsin Department of Transportation (WiDOT) received a $400,000 grant from NOAA to continue work on the state's Height Modernization Plan, which includes leveling and GPS surveys conducted using NOS NGS-58, "Guidelines For Establishing GPS-Derived Ellipsoid Heights," and the draft NGS "Guidelines for Establishing GPS-Derived Orthometric Heights." WiDOT has completed the GPS and leveling surveys in three out of ten areas, or phases, of their plan. The surveys, conducted both with WiDOT personnel and private contractors, have been submitted to NGS and loaded in the NGS database. Phase 4 leveling will begin in July 2003 and mark setting for Phase 5 is scheduled for late 2003. Plans for a User Forum in late 2003 are in progress. Please contact Gilbert.Mitchell@noaa.gov for more information.

Status of Contracting Process

NGS has four firms, with 18 sub-contractors, under contract to perform Height Modernization surveys. All four companies are currently working in North Carolina as detailed in the North Carolina paragraph above. Each of these contracts is for five years and the contractors can work anywhere in the United States. Planning is currently underway for work in a fifth North Carolina county. Please contact George.Leigh@noaa.gov for more information.

Research and Development

NGS Uses Kinematic GPS to Measure Elevations in Southeastern Louisiana

Analysis and modeling

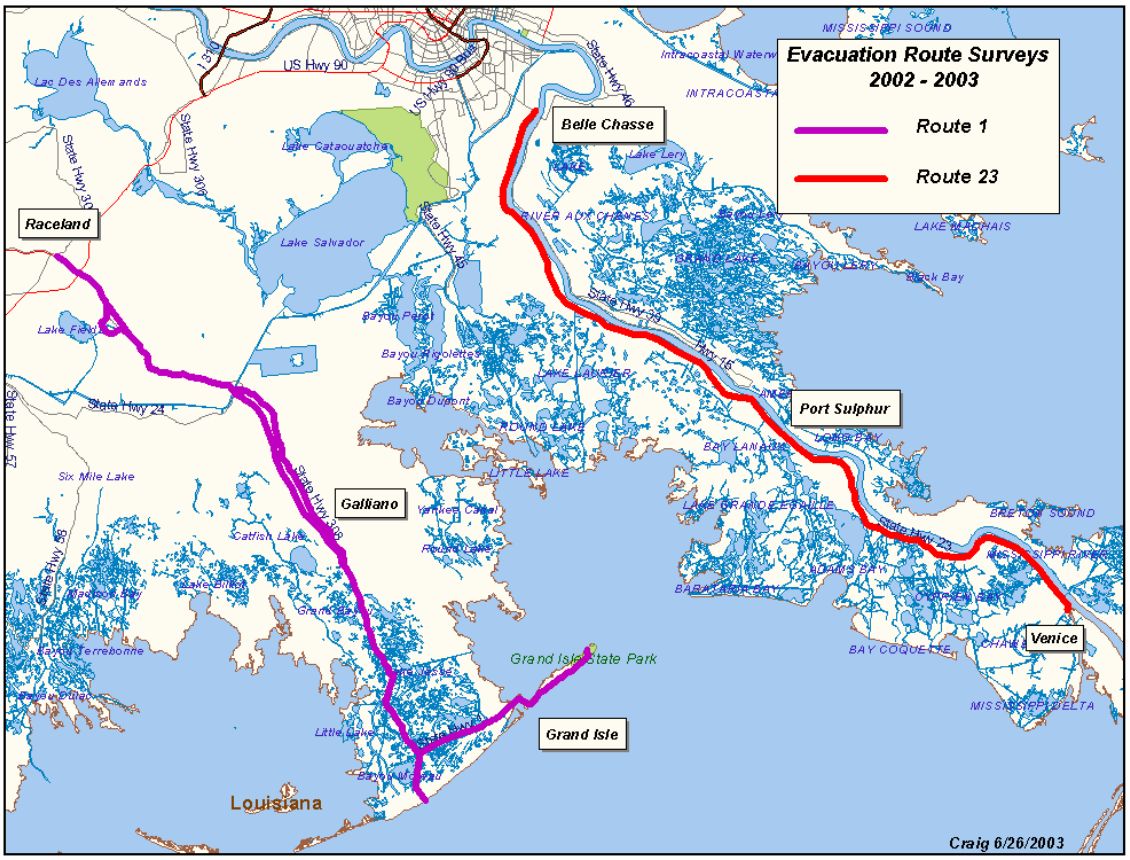
To address the complex subsidence and elevation issues in Louisiana, NGS and the Louisiana Spatial Reference Center (LSRC) developed the Vertical Time-Dependent Positioning (VTDP) plan, an approach to model subsidence rates and define a vertical control network for Louisiana. Beginning with the Southeast region of the state, LSRC and NGS analyzed empirical data from historic leveling projects, the geoid, and GPS observations to determine rates of subsidence and identify potential monuments to use as future survey control.

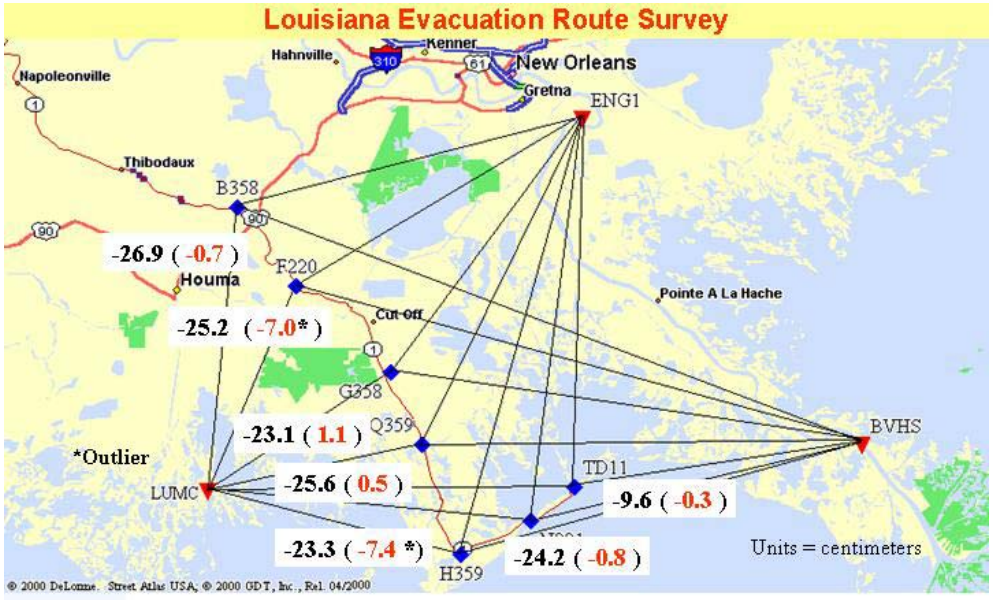
Validation of rates

In October 2002, NGS re-measured the elevations of points along LA Highway 1 from Grand Isle to Raceland, a major hurricane evacuation route for Lafourche and Jefferson Parishes. The survey consisted of static and kinematic GPS observations and leveling. The project served two purposes: (1) validation of the computed VTDP rates, and (2) establishment of accurate elevations of the highway to aid in emergency planning and evacuations during future storms. Officials will be able to use the data to better predict when roads will flood and when evacuation needs to occur. The data from this study indicated that portions of coastal Louisiana could lose up to one foot of elevation over the next decade. Validation of the VTDP model and updated elevations on a select number of bench marks in the Southeast region are in progress. VTDP models for the other regions will follow.

Kinematic GPS guidelines

In order to further develop and test the guidelines for kinematic GPS surveys, in June 2003, NGS performed a second evacuation route survey to measure the road and levees along Highway 23 in Plaquemines Parish, Louisiana. NGS, in collaboration with the Corps of Engineers, the Department of Transportation and Development, Louisiana State University, the Louisiana State Police, and the Plaquemines Parish Government, profiled approximately 70 miles of Highway 23 using kinematic GPS and tied a network of benchmarks along the Highway to the National Water Level Observation Network (NWLON) at Grand Isle through static GPS observations. The development of the NGS guidelines for kinematic GPS surveys will enable interested parties to perform surveys to NGS standards. For more information, please contact Kendall.Fancher@noaa.gov.


Evacuation Route Surveys
2002 - 2003
Route 1
Route 23
Belle Chasse
Raceland
Port Sulphur
Galliano
Grand Isle
Venice
Grand Isle State Park
Louisiana
Craig 6/26/2003


Louisiana Evacuation Route Survey
Hahnville
Kenner
New Orleans
Gretna
Napoleonville
ENG1
Thibodaux
B358
-26.9 (-0.7)
F220
Houma
Pointe A La Hache
-25.2 (-7.0*)
Cut-Off
G358
-23.1 (1.1)
Q359
BVHS
*Outlier
LUMC
-25.6 (0.5)
TD11
-9.6 (-0.3)
-23.3 (-7.4 *)
H359
-24.2 (-0.8)
Units = centimeters
© 2000 DeLorme. Street Atlas USA, © 2000 GDT, Inc., Rel. 04/2000
Black - Estimated Amount of Subsidence Since 1982 Leveling
Red - (Difference between GPS-derived Orthometric Height and VTDP Height)

NGS Lays Groundwork for Successful Restoration Effort

NGS personnel conducted a third Kinematic Global Positioning Satellite survey on Wednesday, September 4, in support of a marsh restoration project at Fort McHenry, near Baltimore, MD. NGS is partnering with the Maryland Port Administration, the Maryland Transportation Authority, the National Aquarium in Baltimore, and the U.S. Geological Survey for this mitigation project.

In addition to the GPS observations, NOS will also compute tidal datums from the local tide station and will be performing high water analyses from this station and the nearby National Water Level Observation Network station at Baltimore, Fort McHenry. The GPS observations will be used to generate a Digital Elevation Model (DEM) for the site, and the tidal datums will be delineated onto the DEM. The final DEM will contribute to what is hoped to be a successful restoration effort. For more information, please contact Joe Evjen@noaa.gov.

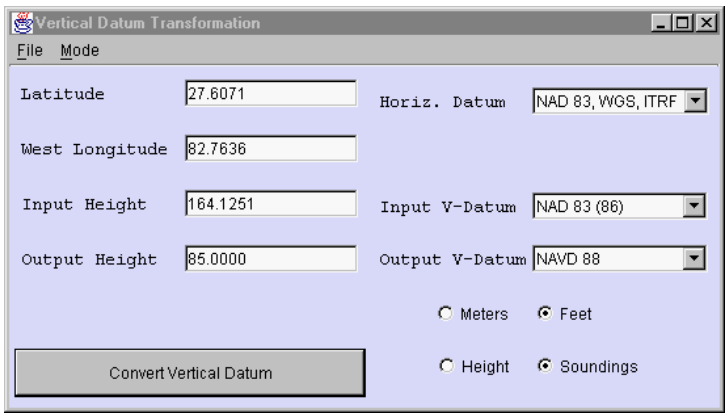
VDatum Technology and Availability Expanded

In FY 03, NGS, partnering with the U.S. Geological Survey, recently released a software package, called VDatum, that allows the non-traditional geodetic user to integrate geospatial data products. By fusing diverse data into one application, this transformation tool reduces personnel and cost needs and increases efficiency in mapping and charting.

This project began in December 1999 when Dennis Milbert, chief geodesist at NGS, met with other colleagues from NOAA and USGS at a User Forum held in Tampa Bay. Users had trouble with the conflicting depictions of shoreline on USGS maps and NOAA nautical charts, and they frequently had to resort to elaborate GIS processing to circumvent the discrepancies. The different depictions were rooted in both shoreline change as well as the vertical datum defining the shoreline. In consultation with Bruce Parker and his lab in the Office of the Coast Survey, Dennis Milbert created VDatum – a technology for vertical datum transformation.

This technology not only supports the creation of seamless bathymetry and topography data sets, but also supports extraction of shoreline referenced to desirable vertical datums and more efficient collection of hydrographic and remote sensing data. When applied to the shoreline problem, VDatum becomes an invaluable tool. A shoreline has a vertical datum imbedded in it. Changing a shoreline's vertical reference will cause translations in the

shoreline and will also change the shape of the shoreline. Knowing the exact vertical datum of shoreline is important because of land and legal issues intrinsically tied to shoreline. As a Java application, VDatum is portable across many platforms and can transform heights and soundings between vertical datums. The software works in two modes, interactive and batch, and incorporates regional datum transformation grids. It supports 28 different vertical datums. VDatum's open source, portable implementation allows this technology to be imbedded in GIS software systems. It is also validated against geodetic control, including leveled benchmarks, GPS control points, and tide gauges. Eventually, VDatum will be extended to cover the entire U.S. coastline, and accuracy maps will be available for the transformations. Current models, including the regions of Tampa and Delaware Bays, North/Central California, Southeast Louisiana, and the New York/New Jersey Bight, are available at http://www.chartmaker.ncd.noaa.gov/bathytopo/vdatum.htm. For more information, please contact Dennis Milbert@noaa.gov.



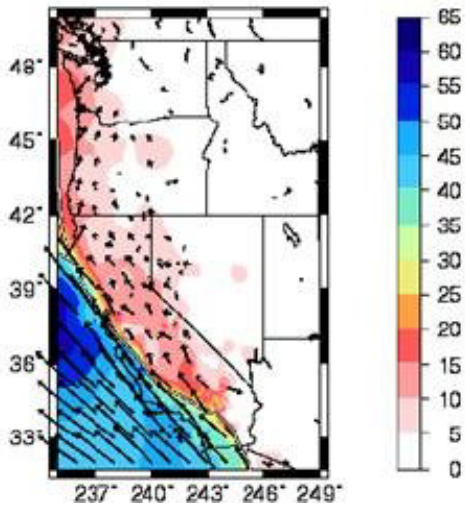
VDatum transformation tool

Version 2.7 of HTDP

In FY 03, NGS released version 2.7 of the HTDP (Horizontal Time- Dependent Positioning) software for transforming positional coordinates and/or positioning observations across time and between spatial reference frames. Users may also apply HTDP to predict the velocities and displacements associated with crustal motion in several popular reference frames. Version 2.7 expands the list of permissible reference frames to include the new realization of the World Geodetic System of 1984, as well as two new reference frames related to the North American Datum of 1983, NAD 83(PACP00) and NAD 83(MARP00). Version 2.7 allows users to input ellipsoidal heights for points via the *86* record of the "BlueBook." (See http://www.ngs.noaa.gov/FGCS/BlueBook/)

The output of Version 2.7 displays input velocities when users apply HTDP interactively to transform positional coordinates. Version 2.7 incorporates a more accurate model than previous HTDP versions for the 3D displacements associated with the magnitude 7.1 Hector Mine, CA earthquake of October 16, 1999.

Users may execute HTDP_2.7 interactively at http://www.ngs.noaa.gov by clicking on "Geodetic Tool Kit" and then on "HTDP." Users may also download the HTDP software and related information from this Web site. For more information, please contact Richard.Snay@noaa.gov.



Horizontal velocities across the Western United States. Colors specify speed in mm/yr and arrows specify corresponding directions of motion relative to a fixed North American plate reference frame.

Topographic LIDAR Survey in Alaska

Between May 12-24, 2003, NOAA's Citation aircraft, in collaboration with the NOAA Ship Rainier, acquired LIDAR (Light Detection and Ranging) data along the shoreline of Kruzof Island and the western shore of Baranof Island in Alaska. The data will be used as an initial development of standards and specifications for the use of Topographic LIDAR technology to meet the shoreline mapping needs of NOAA's Coastal Mapping Program (CMP). Extraction of new shoreline and features will be done by establishing a direct relationship between the GRS80 ellipsoid (NAD83) and the local tidal datums of Mean Higher Water (MHW) and Mean Lower Low Water (MLLW) by static GPS occupations on the Tidal Bench Marks and using OPUS. Once determined, the ellipsoidal equivalents to MHW and MLLW are then auto extracted from the LIDAR derived terrain data. In Sitka the ellipsoidal equivalents for MHW was determined to be 3.320 m and for MLLW 0.529 m. Three separate flights of LIDAR were collected on May 16, 17, and 18; in all cases, the requirements were for the flight to coincide with the times of lowest low water so as to expose most of the shoreline, alongshore rocks, and features. In both cases the data were processed and shorelines were extracted in the same day. This marks a huge step forward in delivering shoreline to NGS customers versus our traditional product derived from tide coordinated photogrammetry, which might take several months to collect and process. While LIDAR data does not have the capability to classify the shoreline as well as tide coordinated photogrammetry, it is a another valuable tool that NGS is actively pursuing to support the CMP. In addition to the flight operations, NGS personnel also collected kinematic GPS and Stop and Go GPS measurements for quality assurance determinations. For more information, please contact Mike.Aslaksen@noaa.gov.

NGS Completes Upgrade of Horizontal and Vertical Geodetic Control for the Territory of American Samoa

From July 30 - September 13, 2002, NGS completed the upgrade of horizontal and vertical geodetic control for the territory of American Samoa. This project will result in better positional accuracy required to support the diversity of a Geographic Information System (GIS), engineering, geophysical, and charting and mapping applications for the Territory. NGS performed the work in cooperation with the American Samoa Department of Commerce; American Samoa Department of Public Works; American Samoa Power Authority; NOS' Coastal Services Center; the National Park Service; and the private firms of Ashtech Products Inc and Thales Navigation.
For more information, please contact Ed.Carlson@noaa.gov.

Geodetic Leveling and HARN in the Commonwealth of the Northern Mariana Islands
On May 5, 2003, NGS started work on a High Accuracy Reference Network (HARN) and geodetic leveling project in the Commonwealth of the Northern Mariana Islands, including Saipan, Tinian, and Rota. The HARN survey and geodetic leveling campaign will provide the horizontal and vertical integration and positional improvements required to support the diversity of GIS, engineering, geophysical, and charting and mapping applications.
Using the specifications consistent with the NGS Height Modernization initiative, NGS conducted an integrated survey program to provide positional accuracies better than 1 cm in the horizontal and 2 cm in the ellipsoid height components.
Project partners include the Commonwealth of the Northern Mariana Islands, Department of Lands and Natural Resources, Commonwealth of the Northern Mariana Islands Coastal Resources Management, NOS Coastal Services Center, and NOS Pacific Services Center.
For more information, please contact Ed.Carlson@noaa.gov.

Special Projects and Events

Lewis and Clark Commemorative Marker

Over the next three years, NGS, in partnership with the National Park Service (NPS), will celebrate Lewis and Clark's industry and discovery with a series of commemorative geodetic survey markers set at signature sites along the Lewis and Clark National Historic Trail. NGS and NPS dedicated the first marker in the series at Thomas Jefferson's home at Monticello, near Charlottesville, Virginia, during the kick-off celebration of the Lewis and Clark Expedition in January. On April 12, NGS dedicated the second marker in this series at Harpers Ferry. NGS currently has plans to place markers at 14 more signature sites along the Lewis and Clark National Historic Trail. The next dedication ceremony will take place at the Falls of the Ohio over the weekend of October 24-26, 2003. For more information, please contact Dave.Doyle@noaa.gov.

Commemorative markers at Harpers Ferry, West Virginia, and at Monticello near Charlottesville, Virginia

Workshops

Continuously Operating Reference Stations	Anchorage, AK	May 2003	American Society for Photogrammetry and Remote Sensing
Spatial Foundations of GIS/LIS	Phoenix, AZ	March 2003	American Congress on Surveying and Mapping
GPS Derived Heights	Phoenix, AZ	March 2003	American Congress on Surveying and Mapping
Continuously Operating Reference Stations	Phoenix, AZ	March 2003	American Congress on Surveying and Mapping
Continuously Operating Reference Stations	Durango, CO	June 2003	Professional Land Surveyors of Colorado
Continuously Operating Reference Stations	Ames, IA	March 2003	Society of Land Surveyors of Iowa
Future of NSRS	Jackson, MS	February 2003	Mississippi Association of Land Surveyors
State Plane Co-ordinates and Datum Transformations	Jackson, MS	February 2003	Mississippi Association of Land Surveyors
Developing an Accurate GIS	Atlantic City, NJ	February 2003	New Jersey Society of Professional Land Surveyors
State Plane Coordinates and Datum Transformations	Catskill, NY	January 2003	New York State Association of Professional Land Surveyors
GPS Derived Heights	Catskill, NY	January 2003	New York State Association of Professional Land Surveyors
Future of NSRS	Bryson City, NC	October 2002	South West Community College

Workshops

Future of NSRS	Corvallis, OR	February 2003	Oregon State University
Continuously Operating Reference Stations	Hershey, PA	January 2003	Pennsylvania Society of Land Surveyors
Datums and Projections	Charleston, SC	January 2003	NOS Coastal Services Center - GeoTools '03
State Plane Coordinates and Datum Transformations	Nacogdoches, TX	June 2003	Texas Society of Professional Surveyors
HARN and NSRS	Fairfax, VA	April 2003	Garrett Moore/ Surveyors Apprenticeship Program
Geodesy Basics	Korror, Palau	March 2003	Guam Society of Professional Register Land Surveyors